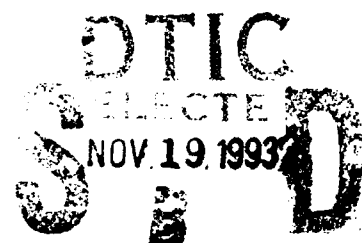


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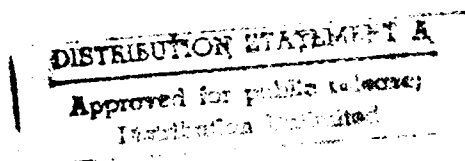
# Operational Test and Evaluation (OT&E) Operational Air Traffic Control Evaluation Plan for the Prototype Airport Surveillance Radar Wind Shear Processor (ASR-WSP) at Albuquerque International Airport

Patrick Martin



October 1993

DOT/FAA/CT-TN93/19



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16. Abstract  The Massachusetts Institute of Technology, Lincoln Laboratories (MIT-LL), operating in support of the Federal Aviation Administration (FAA) Terminal Radar Program has developed a prototype Wind Shear Processor (WSP) modification to interface with Airport Surveillance Radars (ASR) 8 and 9. The WSP enables the ASR radars to automatically detect low altitude wind shear phenomena such as microbursts and gust fronts.  This plan describes the methods, procedures, roles, and responsibilities in evaluating the operational suitability and effectiveness of an ASR-9 with the WSP modification in the high and dry climate of Albuquerque, NM. The suitability evaluation is limited to the performance of the WSP's displays in the human factors environment of the Air Traffic Control (ATC) Tower and Terminal Radar Approach Control (TRACON).			
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## EXECUTIVE SUMMARY

The Massachusetts Institute of Technology, Lincoln Laboratory (MIT-LL), operating in support of the Federal Aviation Administration (FAA) Terminal Radar Program Office, ANR-200, has developed a prototype Wind Shear Processor (WSP) modification that will interface with the Airport Surveillance Radars (ASR) 8 and 9. The modification will enable the ASR radars to automatically detect thunderstorm-generated low altitude wind shear phenomena such as microbursts and gust fronts.

The ASR-WSP has been evaluated extensively during the summer thunderstorm seasons in the southeastern United States since 1987 with good results. The ASR-WSP test-bed system has been deployed for the summer of 1993 to Albuquerque, NM, in order to evaluate its capabilities in a high and dry climate.

This plan describes the methods, procedures, roles, and responsibilities in evaluating the operational suitability and effectiveness of the prototype ASR-WSP at Albuquerque, NM. The prototype was not designed with the emphases on suitability factors; such as compatibility, reliability, logistics support, etc. Suitability evaluation will be limited to the human performance factors of the displays in the Air Traffic Control (ATC) Tower and Terminal Radar Approach Control (TRACON).

## 1. INTRODUCTION.

The Massachusetts Institute of Technology, Lincoln Laboratory (MIT-LL), operating in support of the Federal Aviation Administration (FAA) Terminal Radar Program, ANR-200, has developed a Wind Shear Processor (WSP) modification that will interface with the Airport Surveillance Radars (ASR) 8 and 9. The modification will enable the ASR radars to automatically detect thunderstorm-generated low altitude wind shear phenomena such as microbursts and gust fronts. Future deployment of the WSP modification to various ASR sites will be determined by the FAA. The test-bed system has been operating since 1987 at Huntsville, AL; Memphis, TN; and Orlando, FL, to obtain data for algorithm development, and to demonstrate the ASR-WSP system in operational air traffic control (ATC) environments.

### 1.1 PURPOSE.

The purpose of this Operational Test and Evaluation (OT&E) Operational Air Traffic Control (ATC) Evaluation Plan is to describe the methods, procedures, roles, and responsibilities in evaluating the operational suitability and effectiveness of the prototype ASR-WSP.

The ASR-WSP test-bed system has been deployed to Albuquerque International Airport for operations during the 1993 and 1994 thunderstorm seasons. The evaluation will be conducted by operational ATC personnel at the Albuquerque Airport Traffic Control Tower (ATCT). Operation of the test-bed system in Albuquerque will provide data on high altitude, dry microburst phenomena (wind shear events with very low radar cross-section) whereas previous tests were accomplished in a moist climate.

## 2. REFERENCE DOCUMENTS.

### 2.1 FAA SPECIFICATIONS.

NAS-SS-1000

National Airspace System (NAS)  
Specification, Volumes III and  
VI, December 1989 (NCP 14367)

FAA-E-XXXX

Airport Surveillance Radar  
Wind Shear Processor  
(ASR-WSP), Date TBD

### 2.2 FAA STANDARDS.

FAA-STD-024a

Preparation of Test and  
Evaluation Plans and Test  
Procedures, August 17, 1987

### 2.3 FAA ORDERS.

FAA-Order 1810.4B

FAA NAS Test and Evaluation  
Policy, October 22, 1992

## 2.4 OTHER DOCUMENTS.

DOT/FAA/CT-TN92/48  
Radame' Martinez

Final Report for the ATC  
Evaluation of the Prototype  
Airport Surveillance Radar  
Wind Shear Processor (ASR-WSP)  
at Orlando International  
Airport, March 1993

MIT/LL Project Report  
ATC-189, M.E. Weber

Airport Surveillance Radar  
(ASR-9) Wind Shear Processor:  
1991 Test at Orlando, FL,  
June 1, 1992

MIT/LL

Test Plan for Operational  
Test and Evaluation of the  
ASR-WSP Wind Shear Processor  
(ASR-WSP) at Albuquerque  
International Airport,  
June 25, 1993

## 3. EVALUATION PHILOSOPHY.

The operational evaluation and the MIT/LL technical evaluation will verify that the ASR-WSP meets the requirements identified in the Verification Traceability Matrix (see appendix A). The ASR-WSP operational evaluation will be conducted to verify that the data received on wind shear and microburst conditions are operationally suitable and effective for ATC supervisors and controllers. The Geographic Situation Display (GSD) and Ribbon Display Terminal (RDT) will be evaluated from the perspective of the controllers and supervisors. Feedback from the air traffic control specialists (ATCS) and supervisors will be obtained via questionnaires.

### 3.1 EVALUATION APPROACH.

The operational evaluation will be conducted at the Albuquerque International Airport (ABQ), Albuquerque, NM. The MIT-LL will set up the test-bed system including the RDTs and GSDs in the control tower and Terminal Radar Approach Control (TRACON).

Once the displays are installed at the designated locations, MIT/LL will train the control tower and TRACON personnel in the interpretation and use of the GSD, and in the use of the RDT. The controllers will focus their evaluation on the RDT and the supervisors will focus their evaluation on the GSD. The system will be evaluated for approximately 8 weeks, and then the questionnaire administration will take place. The Test Conductor from ACW-200D will brief the evaluators on the purpose, scope, and procedures of the evaluation, and spend a month in the ATCT during the evaluation in order to record any comments and events.



#### 4. EQUIPMENT.

##### 4.1 SYSTEM.

The ASR-WSP test-bed system consists of a production ASR-9 with hardware and software modifications necessary to extract low altitude wind shear information. The ASR-WSP's signal interface module, receivers, and converters are housed in a 50-foot van. The digital processor and local displays for the WSP reside in an adjacent 24-foot office trailer. The ASR-9 antenna is situated on a 27-foot tower. The test-bed system includes an Air Traffic Control Beacon Interrogator-5 (ATCBI-5) and 5-foot open array antenna. Data from the ASR-WSP will be presented to operational users via two separate displays.

##### 4.2 REMOTE DISPLAYS.

Geographic Situation Display (GSD). The GSD provides a graphical map showing the locations of precipitation cells, microbursts, gust fronts, the speed and direction of storm cell movement, and the predicted locations of gust fronts 10 and 20 minutes in the future. This display is utilized by the air traffic supervisor in planning traffic flow and runway selection with minimum delay to affected aircraft. Physically, the GSD is a SUN-4 engineering workstation with 17-inch color monitor. Another significant capability of the GSD is the ability to reduce indications of weather resulting from anomalous propagation. A GSD will be placed at the supervisor position in the ABQ tower cab, and a GSD will be placed at the supervisor desk in the TRACON.

Ribbon Display Terminal (RDT). The RDT provides a runway-specific, alphanumeric wind shear alert message intended for readout by local controllers to pilots at the time of issuing clearance for landing or takeoff. Physically, the Ribbon Display is a 12-inch plasma display monitor. An RDT will be located at the Local Control position and the Ground Control position in the tower cab.

#### 5. ORGANIZATION ROLES AND RESPONSIBILITIES.

The principal organizations participating in the evaluation of the ASR-WSP include the following:

- ASR-WSP Program Office, ANR-200
- FAA Terminal Radar Division, ANR-600
- Air Traffic Plans and Requirements Service, ATR-120
- FAA Technical Center Weather/Primary Radar Division, ACW-200D
- FAA Southwest Regional Office, ASW-400 and ASW-500
- Albuquerque Airport Traffic Control Tower
- MIT-Lincoln Laboratory

## 5.1 RESPONSIBILITIES.

ANR-200. ANR-200 has overall responsibility for the ASR-WSP program. As technical agent for ANR-200, ANR-600 has overall technical responsibility for the ASR-WSP. A National Airspace Change Proposal (NCP) is being prepared to waive the Low-Level Wind Shear Alert System (LLWAS) certification (the unit will be covered) and use the ASR-WSP wind speed and direction in an operational environment during the evaluation.

ATR-120. This office endorsed and sponsored the continuation of ASR-WSP testing. ATR-120 will review the Operational Evaluation Plan, questionnaires, monitor the evaluation, and coordinate with the Southwest Regional Office and Albuquerque ATC.

ACW-200. ACW-200 has been designated as the Associate Program Manager for Testing (APMT). The APMT is responsible for the overall management and direction for the ASR-WSP operational evaluation. ACW-200D personnel will develop an operational evaluation plan and associated questionnaires. The APMT will designate an Evaluation Conductor who will participate in the initial site visit to coordinate the evaluation, spend a month in the ATCT recording comments, and administer the questionnaires to the supervisors and controllers. ACW-200 will perform data analysis on all questionnaire data, which will be used in the preparation of a draft final report and a final report.

ASW-400 and ASW-500. Regional Airway Facilities and Air Traffic will support the location, installation, and evaluation of the GSD and RDT in accordance with the Memorandum of Understanding (MOU), between FAA Headquarters, Lincoln Laboratories, Southwest Regional Office, and the Albuquerque ATCT (see appendix B). Operational testing will not commence or be discontinued without coordination with the Southwest Region Air Traffic Division.

Albuquerque ATCT. In accordance with the MOU, the Air Traffic Manager (ATM) will provide the necessary meeting and briefing facilities space to accommodate the evaluation and the participants to evaluate the ASR-WSP.

MIT-LL. In accordance with the MOU, the MIT/LL will provide the ASR-WSP test-bed system, remote displays, and technical personnel, as well as test equipment not on site.

## 5.2 ROLES.

APMT. The APMT is a member of the FAA Technical Center and oversees all aspects of the evaluation including the preparation of the final report.

Evaluation Conductor. The Evaluation Conductor is the FAA Technical Center ACW-200D representative who will coordinate the on-site evaluation. The Evaluation Conductor will participate in all site visits, reviews, and briefings. The Evaluation Conductor will remain at the ATCT during the evaluation in order to record comments, events, and aid in the evaluation. The Evaluation Conductor will support data analysis and the preparation of reports.

Evaluation Participants. The Evaluation Participants are the controllers and supervisors at ABQ who will evaluate the ASR-WSP displays that are installed in the tower and TRACON, including the suitability and timeliness of the weather data generated by the ASR-WSP.

Technical Personnel. The MIT/LL technicians will provide technical support as stated in the MOU.

## 6. DOCUMENT REQUIREMENTS AND CONTROL.

### 6.1 OPERATIONAL EVALUATION PLAN.

The Operational Evaluation Plan describes the requirements, methods, and responsibilities for conducting the evaluation of the ASR-WSP displays located in the tower cab and TRACON. It provides a plan that will allow for an evaluation of the ASR-WSP data by the controllers and supervisors in a live operational environment.

### 6.2 EVALUATION QUESTIONNAIRES.

The evaluation questionnaires will be developed to obtain feedback from the users. The questionnaires will be developed by the FAA Technical Center with input from MIT/LL and ATR-120.

The evaluation questionnaire will consist of three parts: (1) questions concerning the RDT, (2) questions concerning the GSD, and (3) a general free-form section. The questionnaires are organized to highlight the two ASR-WSP displays, system areas, and interfaces that the controllers and supervisors will be asked to evaluate. Following the evaluation, the completed questionnaires will be analyzed by ACW-200D personnel. The data collected will form the basis for a draft final report which will be forwarded to the principal organizations supporting the ASR-WSP evaluation. A final report will follow the draft report.

One of the questionnaires will address the RDT and whether or not the information that is displayed is useful and timely. The other will address the GSD and whether or not the data that is displayed can be interpreted quickly and easily, and is suitable and timely for flow control decisions. The questionnaires will be structured utilizing three forms of questions: (1) rating a statement or function on a five-point scale ranging from Good to Poor, plus a "Don't know"; (2) free-form questions that allow for free written expression; and (3) statements requiring a Yes or No response.

### 6.3 DRAFT FINAL REPORT.

Within 30 days following the end of the evaluation, a draft final report will be submitted to ANR-200 for review.

#### 6.4 FINAL REPORT.

After review and editing of the draft final report, the final report will be prepared and will include the conclusions, problems, issues, and recommendations resulting from the evaluation. This report will be sent to ANR-200 and the other participating organizations within 20 days after receiving comments on the draft final report.

#### 7. TRAINING.

In accordance with the MOU, MIT-LL will provide instruction to the ABQ ATCT supervisors and controllers on the operation of the GSD and RDT displays and interpreting the data displayed on the GSD. Phase 2 of the evaluation will not begin until all evaluation personnel have been sufficiently trained in the use and interpretation of the displays.

#### 8. EVALUATION SUPPORT REQUIREMENTS.

##### 8.1 INSTRUMENTATION.

As indicated in appendix B, MOU, MIT/LL will furnish a meteorological C-Band Doppler radar for data collection and verification of the wind shear events. For additional information on the use of data from the MIT radar, consult the MIT-LL Test Plan for the ASR-WSP at Albuquerque International Airport, dated June 25, 1993.

##### 8.2 DATA ANALYSIS.

Numerical values will be assigned to those questionnaire responses that answered with a number and then analyzed. Free-form comments will be analyzed using content analysis. Yes-No questionnaires will be analyzed by majority.

#### 9. REVIEWS AND MEETINGS.

##### 9.1 INITIAL SITE VISIT.

An initial visit to the Albuquerque International Airport and the MIT-LL radar test-bed system will be required to obtain specific information necessary to conduct the evaluation. Information to be gathered includes the number of controller/supervisor participants, layout of the tower cab and TRACON, display equipment being used, duty schedule of participants, etc. This visit will be coordinated with the facility ATM and MIT-LL personnel.

##### 9.2 EVALUATION DECISION MEETING.

The decision to proceed with formal operational testing will be predicated on demonstration of acceptable performance using data collected off-line with the prototype ASR-WSP and support systems. MIT/LL will verify that the performance of the storm movement, gust front detection, and AP censoring functions are operationally acceptable in that they provide operational useful information on storms and do not produce excessive false alarms. The microburst algorithm will be demonstrated to provide an overall detection probability in excess of 0.8 and a false alarm probability less than 0.15.

### 9.3 EVALUATION BRIEFING.

Once the training for the ATCT personnel has been completed, briefings will be held at ABQ to insure that the intent of the evaluation is conveyed. The Evaluation Conductor, who will be providing the briefing, will insure that each participant has been briefed and that all questions and concerns are addressed. The briefing will be held on an as-needed basis so that all duty shifts are covered.

### 10. SCHEDULE.

Coordination with the National Air Traffic Controller's Association (NATCA) will be undertaken by either ANR-200 and/or ASW-500 before testing or the administration of questionnaires begins.

Visit ABQ for meeting	May 3-6, 1993
Test Plan (draft)	May 20, 1993
Test Plan (final)	June 10, 1993
Evaluation Decision Meeting (ABQ)	July 02, 1993
Questionnaire(s) (draft)	June 15, 1993
Install Training Displays at ABQ	July 15, 1993
MIT-LL Staff to Train ABQ Training Staff	July 12 - July 18, 1993
Training of Supervisors and Controllers	July 19 - August 1, 1993
Questionnaire (final)	July 15, 1993
Operational Testing (Phase 1 - use of GSDs only, no information passed to pilots)	July 19 - August 1, 1993
FAA Conduct OT&E Evaluation (Phase 2 1:00 - 8:00 pm, NCP required in order to waive LLWAS certification during test)	August 2 - September 12, 1993
Distribution, Collection of Questionnaires	August 23 - September 1, 1993
Evaluation Report (draft)	25 days after compilation of data
Evaluation Report (final)	20 days after receiving comments on draft

## 11. ACRONYMS AND ABBREVIATIONS.

ABQ	Albuquerque International Airport
ACW-200D	Federal Aviation Administration Technical Center Weather/Primary Radar Division
ANR-200	Terminal Radar Program
APMT	Associate Program Manager for Test
ASR	Airport Surveillance Radar
ATC	Air Traffic Control
ATCBI	Air Traffic Control Beacon Interrogator
ATCS	Air Traffic Control Specialist
ATCT	Airport Traffic Control Tower
ATM	Air Traffic Manager
FAA	Federal Aviation Administration
GSD	Geographic Situation Display
LLWAS	Low-Level Windshear Alert System
MIT/LL	Massachusetts Institute of Technology, Lincoln Laboratories
MOU	Memorandum of Understanding
NATCA	National Air Traffic Controller's Association
NCP	NAS Change Proposal
OT&E	Operational Test and Evaluation
RDT	Ribbon Display Terminal
TRACON	Terminal Radar Approach Control
VRTM	Verification Requirements Traceability Matrix
WSP	Wind Shear Processor

**APPENDIX A**

**OT&E OPERATIONAL TEST REQUIREMENTS VRTM**

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ASR-WSP NAS-SS-1000 REQUIREMENTS				
VOL III PARAGRAPH #	DESCRIPTION	VERIFI- CATION METHOD	QUESTIONNAIRE	REMARKS
3.2.1.1.3.1.7	The ASR-9 shall detect hazardous wind shear in the terminal area	D		
3.2.1.1.3.1.8.a	Provide alerts of hazardous wind shear events in the terminal area for microbursts	D		
3.2.1.1.3.1.9.b	Provide alerts of hazardous wind shear events in the terminal area for wind shears	D		
3.2.1.1.3.1.9.c	Provide alerts of hazardous wind shear events in the terminal area for gust fronts	D		
3.2.1.1.3.2.2.a	Wind shear detection envelope for microbursts and gust fronts shall be 0.125 nmi for slant range	D		
3.2.1.1.3.2.2.b	Wind shear detection envelope for microbursts and gust fronts shall be 360 degrees for azimuth	D		

Verification Methods: T-Test D-Demonstration A-Analysis I-Inspection



ASR-WSP NAS-SS-1000 REQUIREMENTS				
VOL III PARAGRAPH #	DESCRIPTION	VERIFI- CATION METHOD	QUESTIONNAIRE	REMARKS
3.2.1.1.3.2.9.a	Detect microbursts with a differential velocity of greater than 30 knots over a distance of 3 nmi or less	D		
3.2.1.1.3.2.9.b	Detect gust fronts with a measured propagation speed of 10 knots or greater	D		
3.2.1.1.3.2.14.1a	Generate graphical alerts for microburst and wind shear events within 10 nmi of the airport reference point	D		
3.2.1.1.3.2.14.1b	Generate graphical alerts for gust front detection to a range of 15 nmi from the airport reference point	D		
3.2.1.1.3.2.14.1c	Generate graphical alerts for 10 and 20 minute predicted locations of gust fronts and expected wind shifts	D		
3.2.1.1.3.2.14.2a	Generate an alphanumeric alert if a hazardous condition exists along the runway	D		
3.2.1.1.3.2.14.2b	Generate an alphanumeric alert if a hazardous condition exists up to 3 nmi along the runway centerline from the end of the runway for arrivals	D		

Verification Methods: T-Test D-Demonstration A-Analysis I-Inspection

ASR-WSP NAS-SS-1000 REQUIREMENTS				
VOL III PARAGRAPH #	DESCRIPTION	VERIFI- CATION METHOD	QUESTIONNAIRE	REMARKS
3.2.1.1.3.2.14.2c	Generate an alphanumeric alert if a hazardous condition exists up to 2 nmi along the runway centerline from the end of the runway for departures	D		
3.2.1.1.3.2.14.3	Wind shear products generated by a standalone ASR-9 shall be updated at least once every 30 seconds	D		
3.2.1.1.3.2.14.4	Wind shear products generated by integrating ASR-9 and LLWAS products shall be updated at least once every 30 seconds	D		
3.2.1.1.3.2.14.5a	Wind shear mapping accuracies shall be 0.5 nmi for range	D		
3.2.1.1.3.2.14.5b	Wind shear mapping accuracies shall be 1.4 degrees for azimuth	D		

Verification Methods: T-Test D-Demonstration A-Analysis I-Inspection

**APPENDIX B**  
**MEMORANDUM OF UNDERSTANDING**

## **MEMORANDUM OF UNDERSTANDING**

### **ASR-9 WIND SHEAR DETECTION FACILITIES LOCATED AT THE ALBUQUERQUE INTERNATIONAL AIRPORT**

#### **1. Purpose**

The Lincoln Laboratory, operating in support of the Surveillance Engineering Division, ANR-100, has developed a Wind Shear Processor (WSP) modification for the ASR-9 that will enable the radar to automatically detect thunderstorm-generated low-altitude wind shear phenomena such as microbursts and gust fronts. The WSP modification will be deployed nationally at approximately 58 ASR-9 sites beginning in 1997. A testbed system has been operated since 1987 to obtain data for algorithm development, and to demonstrate the WSP system in an operational Air Traffic Control environment.

This Memorandum of Understanding (MOU) covers deployment of the WSP testbed on the Albuquerque International Airport in the fall of 1992 and operations during the 1993 and 1994 thunderstorm seasons from approximately March through September. The testbed will be sited on the southern periphery of the airport between the southern ends of runways 03 and 35. Operation of the testbed in Albuquerque will provide data on "dry" microburst phenomena -- wind shear events with very low radar cross-section -- necessary for refinement of the WSP's algorithms prior to national deployment.

In addition to the WSP activity, the testbed serves as a facility for evaluating enhancements for the hardware and software of the ASR-9 target channel. This work is generally carried out on one channel while the second supports the WSP. It is anticipated that design validation of the enhancement of the Array Signal Processor will be performed while the testbed is deployed at Albuquerque.

#### **2. Description of Wind Shear Processor Testbed and Supporting Systems**

##### **2.1 ASR-9 WSP Testbed**

The WSP testbed consists of a production ASR-9 with hardware and software modifications necessary to extract low-altitude wind shear information. Both channels of the ASR-9 (transmitter, receiver-processor, RMS cabinets and 6-level weather channel) and the WSP's signal-interface module, receivers and A/D converters are housed in a 50 foot Air Ride Van. The digital processor and local displays for the WSP reside in an adjacent 24 foot office trailer. The ASR-9 antenna will be situated on a 27 foot tower. The testbed in Albuquerque will include an ATCBI-5 and five-foot open array antenna. Two sets of 25 KVA diesel generators are used for site operations during thunderstorm activity. Figure 1 is a preliminary plot plan for the Albuquerque site.

##### **2.2 Meteorological Doppler Weather "Truth" Radar**

A C-band meteorological Doppler weather radar is operated to provide "truth" for evaluation and refinement of the WSP's wind shear detection algorithms. The preferred site for this radar will be south of the airport, on the southern edge of Tijeras Arroyo. Coordination with Albuquerque Airway Facilities Sector (ABQ AFS) indicates that the FAA operated remote communication RT/RTR sites "C" and "D" are suitable and acceptable for this radar.

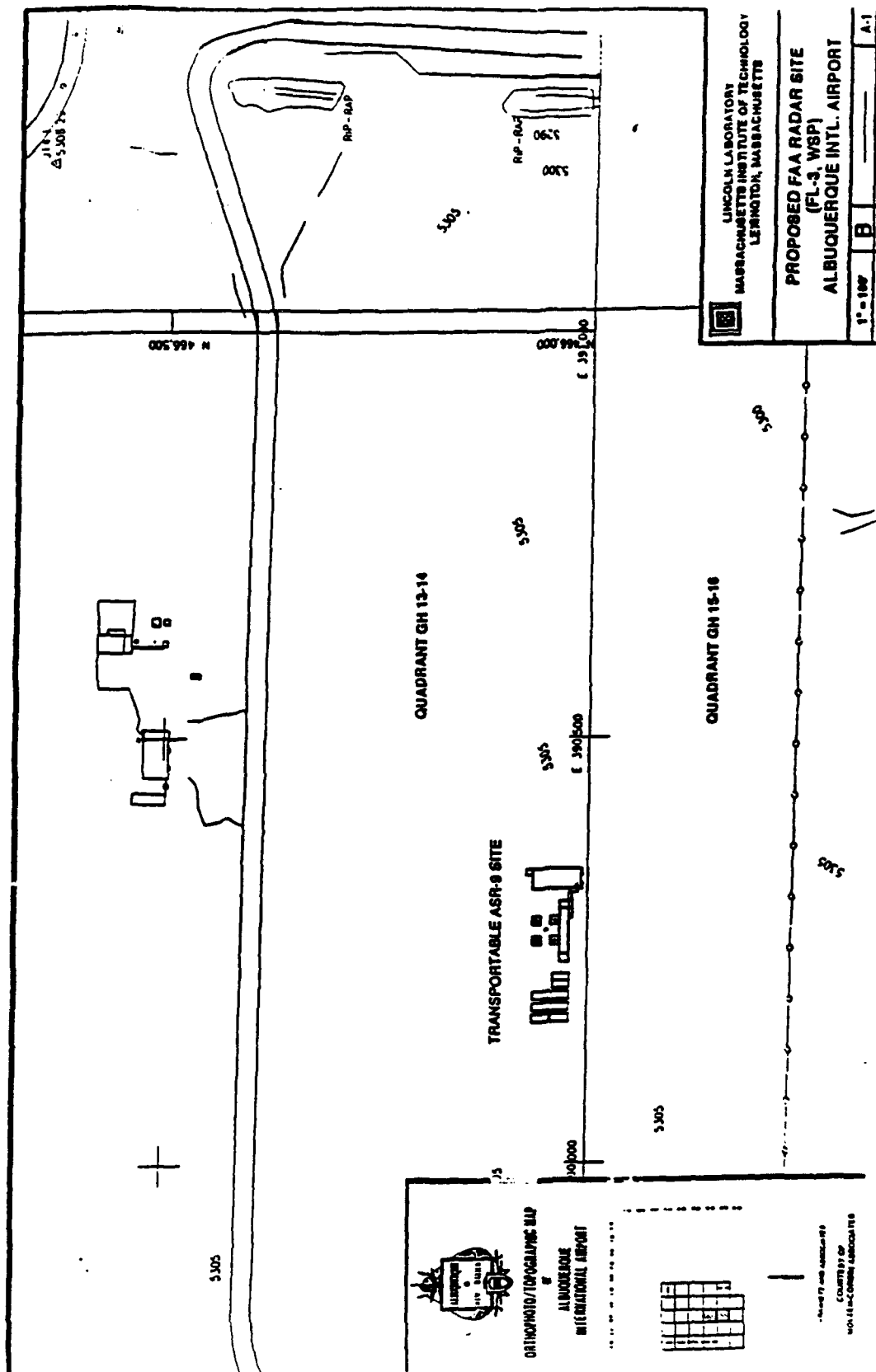


FIGURE 1. DRAFT PROPOSED ASR-9 SITE

### 2.3 Anemometer Towers

A network of anemometer towers are available to provide a surrogate for the expanded Phase III LLWAS system which may eventually be installed at Albuquerque. Data from these sensors allows for validation of algorithms for the integration of WSP and Phase III LLWAS systems. If suitable sites can be located near the Albuquerque airport, up to 15 of these anemometer towers may be deployed by Lincoln Laboratory for the WSP testing.

### 3.0 Information on Operation of the WSP Testbed in Albuquerque

#### 3.1 Frequency

The ASR-9 WSP testbed can operate at any frequency in the ASR S-band. Frequencies of 2865 MHz and 2870 MHz with pulse repetition frequency (PRF) Set 16 have been authorized by FAA for operations. The meteorological "truth" radar is tunable within the band 5570-5670 MHz and transmits a 1 microsecond, 160 KW peak power pulse. Frequency authorization for operation of the ASR-9 WSP, the "truth" radar and ATCBI-5 at Albuquerque shall be requested by Lincoln Laboratory and provided by FAA.

The ATCBI-5 shall operate at standard frequencies. Frequency 1030 MHz and PRF Set 16 and power output shall be as authorized by the FAA.

The Southwest Region Telecommunications and Spectrum Management Branch, ASW-480, is cognizant of frequency authorization. ASW-480 shall be provided with data on all additions or changes to operating frequencies at least 30 work days prior to the anticipated date for activating these changes or additions. No radar frequency shall become operational without the written approval of ASW-480.

#### 3.2 Power

Commercial power will be connected to the site for operations during the fair weather conditions. Lincoln Laboratory will arrange for power connection in coordination with Airway Facilities and Airport personnel. Diesel motor generators will be used to power the site whenever lightning activity within 50 nautical miles is expected. An above ground fuel storage tank for the generator set will be installed by Lincoln Laboratories in accordance with the FAA Southwest Region standard above ground fuel tank drawing SW-SD-FST-M07 and the requirements of the New Mexico State Fire Marshall.

#### 3.3 Radar Tower

The ASR-9 antenna and ATCBI open array will be placed on a 27-foot, standard ASR tower. Lincoln Laboratory will install and maintain lightning rods and hazard warning lights. At the selected site, the tower will be installed in full compliance with FAA runway obstruction guidelines and FAR Part 77 requirements.

ANR-100 will provide a tower suitable for the ASR-9 delivered to the designated site in Albuquerque. Foundations and site grading necessary for the tower will be arranged for by Lincoln Laboratory and coordinated with Airway Facilities and Airport personnel.

### 3.4 Shelters

The WSP site is composed of a total of seven mobile shelters;

- (i) 50 ft. air-ride trailer housing the ASR-9 and WSP front-end;
- (ii) 24 ft. by 56 ft. office and display trailer;
- (iii) two 40 ft. trucks housing the diesel motor generators;
- (iv) two 8 ft. by 40 ft. storage shelters;
- (v) 8 ft. by 40 ft. workshop shelter.

Installation by Lincoln Laboratories of any additional shelters, if required, shall be coordinated with Albuquerque Airway Facilities and Airport personnel.

### 3.5 Communications

Lincoln Laboratory will provide telephone communications as required. The TELCO Demarc will be located in the existing ATCT/TRACON equipment room. All installation work will be coordinated with the Establishment Engineering Branch, ASW-450, and ABQ AFS.

Termination equipment will require space in the ATCT/TRACON equipment room. The equipment will be provided by Lincoln Laboratory. The site location will be coordinated with ABQ AFS.

### 3.6 WSP Remote Displays

The primary purpose of WSP operations in Albuquerque is to obtain on dry-microburst phenomena necessary for off-line optimization of the data processing algorithms. If desired by Southwest Region and Albuquerque Air Traffic, the WSP testbed is configured so as to be capable of providing real-time automated weather and wind shear information to the ABQ TRACON and ATCT or other remote users.

Data from the WSP are presented to operational users via two separate displays. The Geographic Situation Display (GSD) provides a graphical map showing the locations of precipitation cells, microbursts, gust fronts, the speed and direction of storm cell movement and the predicted locations of gust fronts 10 and 20 minutes in the future. One GSD is normally located in the tower cab for use by the tower supervisor; a second GSD is provided in the TRACON for use by the Area Supervisor. Physically, the GSD is a SUN-4 engineering workstation with 17" color monitor. Installation of all GSD and ribbon displays at the ATCT CAB and TRACON will be accomplished by Lincoln Laboratory in coordination with local Air Traffic and Airway Facilities Managers.

The "ribbon" display provides a runway-specific, alphanumeric wind shear alert message intended for read-out by local controllers to pilots at the time of issuing clearance for landing or takeoff. Ribbon displays have typically been located at each local and ground control position in the tower cab. The ribbon display is physically a 12" monochrome video monitor.

The decision to issue wind shear data derived from the ASR-9 will be made by the Manager, Albuquerque Airport Traffic Control Tower, contingent upon an approved National Airspace System Change Proposal (NCP). Request for such NCP must be initiated by Lincoln Laboratory and ANR-100.

Lincoln Laboratory, with assistance from the Establishment Engineering Branch, will be responsible for moving equipment to the new control tower if relocation occurs, and if required, restore console to original condition when equipment is removed.

### **3.7 Hours of Operation**

The WSP site is staffed so as to operate during most daytime periods of active weather. During periods when data are provided for usage in the ATCT, scheduled operating times shall be 12:00 noon to 7:00 p.m. local time. At the discretion of onsite personnel and in coordination with ABQ Air Traffic Managers, operations may begin earlier or continue later if weather conditions at the airport so dictate.

Lincoln Laboratory will cease any equipment operation or other activity which interferes with the FAA mission. Authority to demand such cessation is vested in the local Air Traffic and Airway Facilities Managers. Also, Lincoln Laboratory must coordinate with ABQ Air Traffic and ABQ Sector prior to bringing any visitors to the ATCT/TRACON facility.

### **3.8 Maintenance/Logistics**

Lincoln Laboratory shall install and subsequently remove all equipment and infrastructure related to its site operations. This also applies to the displays described in paragraph 3.6.

Maintenance parts for the ASR-9 WSP testbed are supplied by the FAA Logistics Center. Where possible, ABQ Sector will provide assistance on the requisition of FAA supplied parts from the FAA Logistics Center.

### **3.9 Site Information**

#### **3.9.1 ASR-9 WSP System at Albuquerque International Airport**

Preliminary site plan drawings and specifications prepared by a professional architectural and engineering firm shall be submitted to the FAA Airway Facilities Division, Resources and Planning Branch, ASW-420 (2 copies), the Albuquerque Airway Facilities Sector (2 copies), the City of Albuquerque Airport Director's Office and if required, Kirtland Air Force Base for review prior to final approval. The approval of the FAA Airway Facilities Division is required prior to release of the drawings for bidding purposes or for construction.

Security and environmental procedures of the Albuquerque International Airport will be complied with. All access to the ASR-9 wind shear test site shall be arranged for by Lincoln Laboratories with the City of Albuquerque Airport Director's Office, subject to the on-airport liability policies of the City.

#### **3.9.2 Meteorological Doppler Weather Radar Site**

A preliminary selection of FAA Remote Communications RT/RTR site (either C or D) located south of the airport has been selected for the meteorological radar. Further examination of suitability of the sites must be performed and permission for use must be obtained from the cognizant FAA organization.



#### **4.0 Cognizant Organization and Personnel**

##### **4.1 FAA Headquarters**

Carmine Primeggia (ANR-100)	202 606-4620
John Horrocks (ANR-120)	202 606-4613
Gerald Taylor (ANR-200)	202 606-4622

##### **4.2 Lincoln Laboratory**

Mark Weber	617 981-7434
Melvin Stone	617 981-7426
Raymond LaFrey	617 981-7420

##### **4.3 Southwest Region Office**

John Dobelman (ASW-420)	817 740-3421
John Marut (ASW-450)	817 740-3105
Bill Allen (ASW-480)	817 740-3237
James Nausley (ASW-510)	817 624-5510

##### **4.4 Albuquerque**

Leroy Powell (ABQ SM)	505 764-6700
Rich Macha (ABQ AM for TSS)	505 764-6740
Jerry A. Johnson (ABQ ATCT Mgr.)	505 764-6900
William Hill (Assistant ATCT Mgr.)	505 764-6900
Ron Flatt (ABQ ATCT AMP)	505 764-6900

#### **5.0 Schedule**

Dates will be coordinated with designated personnel at Southwest Region Office and Albuquerque FAA offices. Site preparation work in preparing the WSP site for occupation by Lincoln Laboratory is scheduled to commence approximately October 1992. Setup of the tower and shelters and hookup of electric and communications lines will commence in November 1992. The WSP testbed will operate in shakedown mode in January 1993.

The WSP testbed will operate at Albuquerque until approximately September 1994.

#### **6.0 Technical and Operational Information Exchange**

##### **6.1 Overview Briefing**

A background and technical briefing on the WSP system and the planned activities at Albuquerque was conducted at Southwest Region Office on July 17, 1992, and at the Albuquerque airport on July 18, 1992.

##### **6.2 Operations Briefing**

Technical briefings will be presented to AT managers, supervisors, training officers and controllers and Airway Facilities management and personnel on radar detection of wind shear and related topics needed to support operations. These briefings will be performed as requested by the ABQ AT and AF managers.

MEMORANDUM OF UNDERSTANDING

ASR-9 WIND SHEAR DETECTION FACILITIES LOCATED AT THE  
ALBUQUERQUE INTERNATIONAL AIRPORT

The FAA and MIT Lincoln Laboratory hereby mutually agree to the provisions of the memorandum of understanding as is indicated hereon.

*J. W. Stetson*  
Manager, Airway Facilities Division, ASW-400

10-7-92  
Date

*John R. D'Amico*  
Manager, Air Traffic Division, ASW-500

10/3/92  
Date

*Samuel R. Pappas*  
Manager, Surveillance Engineering Division, ASR-100

10/14/92  
Date

*Malvin L. Stone for Mark Weber*  
Manager, MIT Lincoln Laboratory

10/16/92  
Date